PRELIMINARY STUDIES ON THE DIVERSITY OF SPIDER FAUNA (ARANEAE: ARACHNIDA) IN PARAMBIKULAM WILDLIFE SANCTUARY IN WESTERN GHATS, KERALA, INDIA

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147 species of spiders belonging to 82 genera and 22 families are recorded from Parambikulam. 51 species are new records for Kerala State and 5 species are new records for India. Moist deciduous forests exhibit higher diversity of spiders compared to evergreen forests. Spider fauna of Parambikulam exhibits affinities with Oriental and Palaearctic regions. 45 species recorded are endemic to the Indo-Sri Lankan region. Family Mimetidae is a new record from southern India. Key to different spider families found in Parambikulam also incorporates all the families so far recorded from Kerala. Distributional data based on literature of all the spiders recorded are included.

Key words: Parambikulam Wildlife Sanctuary, spiders, biodiversity, Western Ghats, endemism, affinities, zoogeography, India

INTRODUCTION

Though spiders form one of the most ubiquitous and diverse groups of organisms existing in Kerala, their study has remained largely neglected. Once completely enumerated, their species diversity will outnumber all groups other than insects. Due to high species endemism, the Western Ghats are listed among the twenty-five 'biodiversity hotspots' of the world. Parambikulam Wildlife Sanctuary is one of the thickest undisturbed forest patches existing in the Western Ghats. Inaccessibility of these forest areas has considerably facilitated their protection. Due to scarcity of workers much of the arthropodan diversity remains unexplored, and the disappearance of many species undocumented, so that any scope for their future utilization ceases. Considering the importance of spiders in the natural suppression of many insect pests, urgent efforts are needed to understand their diversity. Our knowledge about the spiders of Kerala remains confined to the works of Ferguson (1906), Gravely (1915, 1921a, 1931, 1935), Pocock (1900) and Sinha (1951a, b). The number of species previously recorded from Parambikulam is only 91 (Patel 2003); our study helps to raise this number to 147. Though the study of spiders from Parambikulam is still far from complete, the present study will form a basis for further investigations on this group.

STUDY AREA

Parambikulam Wildlife Sanctuary (10° 20'-10° 26' N; 76° 35'-76° 50' E) is situated between the Anamalai ranges of Tamil Nadu and the Nelliampathy ranges of Kerala. It comprises a total area of 285 sq. km with a reservoir area of 28 sq. km. Elevation ranges from 300 m to 1,430 m, with average elevation being 600 m. Annual rainfall is 1,720 mm, most rain being received in June-August while the eastern part of the Sanctuary adjoining Tamil Nadu receives most rain in October-November. The Sanctuary has both natural forest and plantations. Evergreen – semi-evergreen forest (about 80 sq. km) is found along the northern and north-western borders, moist deciduous forest (70 sq. km) is mostly in the central portion and small patches of dry deciduous forest in the drier parts adjoining Tamil Nadu. Plantation, mostly of Teak, occupies 90 sq. km of area. These plantations with a belt of deciduous forest interspersed with marshy areas (*vayals*) present a mosaic type of vegetation unique to Parambikulam. Temperature ranges from a maximum of 27-33 °C to a minimum of 20-24 °C.

METHODOLOGY

Spiders were studied following the methods of Tikader (1987). The study was of limited duration extending for six days from September 08, 2001 to September 13, 2001. Five areas (Fig. 1) were selected for study:

1) Moist Deciduous forest around Anappady (10° 26' 36.9" N; 76° 48' 50.1" E; 564 m),
2) Moist Deciduous forests at Kuriyarkutty, along the former forest Tram way (10° 24' 22.1" N; 76° 43' 16.9" E; 534 m),

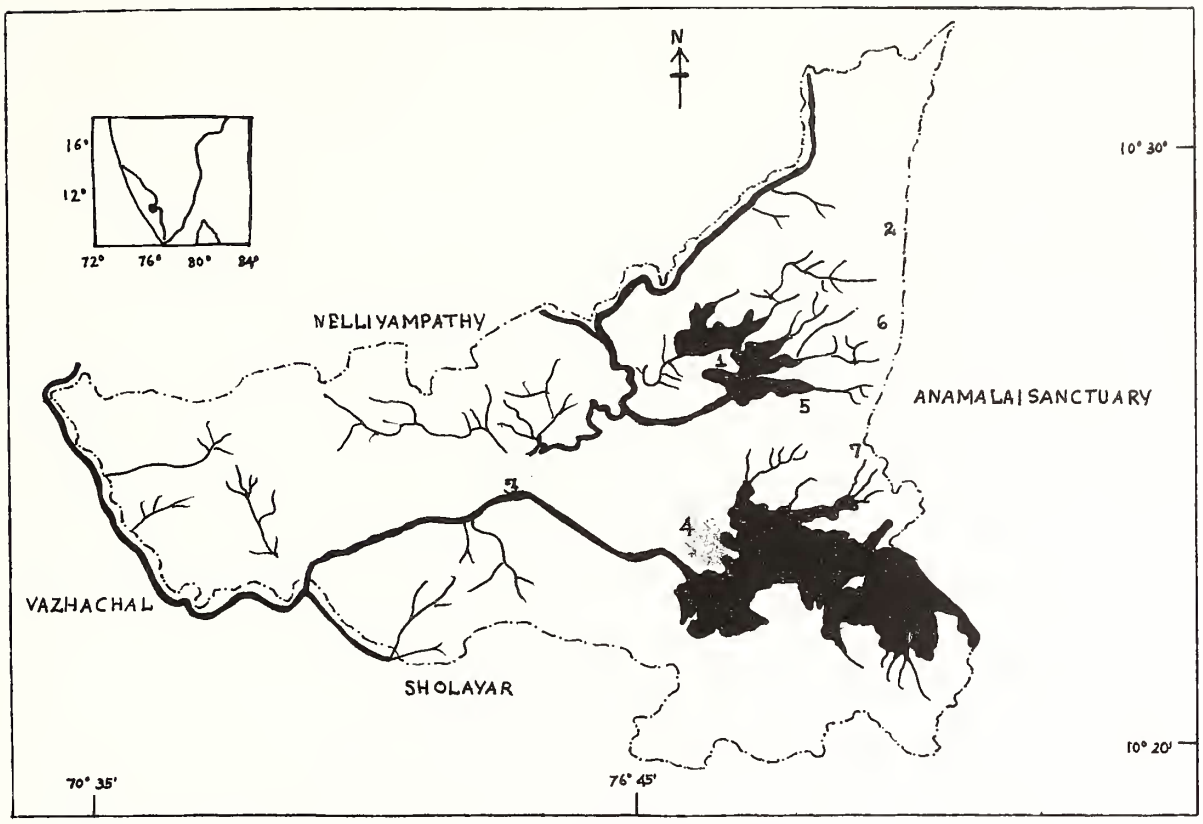

Fig. 1: Map of Parambikulam Wildlife Sanctuary: 1. Thunacadavu, 2. Karianshola, 3. Kuriarkutty, 4. Parambikulam, 5. Vengolimala, 6. Anappady, 7. Vengoli

3) Evergreen forest located at Karianshola (10° 27' 44.3" N; 76° 49' 39.2" E; 742 m),
4) Evergreen forest tread path from Karianshola to Vengolimalai,
5) Moist Deciduous forest at Vengoli (1,200 m) and Vengolimala (968 m), located east of the Sanctuary.

Bushes, tree trunks, forest floor and foliage were all searched for spiders. Observation was conducted in moist deciduous forest around Anappady, also at night. A hand unit of Global Positioning System (GPS) was used to determine the exact geographical locations. To indicate the differentiation diversity (Beta Diversity), Jaccard index was used. Jaccard Index cj = j / r x 100 where j = the number of species found at both sites, r = the number of species at one site.

The identification of spiders was done following Gravely (1915, 1921a, 1921b, 1924, 1931, 1935), Koh (1989), Majumder and Tikader (1991), Pocock (1900), Sherriffs (1919, 1927, 1928, 1929), Sinha (1951a,b), Tikader (1970, 1977, 1980, 1982). The families are arranged after Platnick (2001). Since many changes have occurred in the taxonomic names, older names are retained in brackets to avoid confusion. Data regarding the general distribution is taken from Platnick (2001) and Tikader (1980, 1982). Based on our observations, status of each species is indicated as 'rare' or 'common'. The key provided is modified from Ovtsharenko *et al.* (2001); some families that are not recorded from Parambikulam, but found in other regions of Kerala are also included in the key.

Small dash in the Table 1 indicates that the species was not collected during the present study, but has been previously reported from Parambikulam. ('-' is present in space corresponding to status and habit, eg. No. 15, 51, 56 etc.)

RESULTS

Key to spiders of Parambikulam

1	Eight eyes present	2
—	Six eyes present	30
2	Cribellum absent	3
—	Cribellum present	26
3	Chelicerae downward or downward and forward, cheliceral fangs directed towards each other	4
—	Chelicerae projecting forward, cheliceral fangs directed more or less parallel to the main body axis	Theraphosidae
4	Tarsi with three claws	5
—	Tarsi with two claws	16
5	Spiders with extremely long and thin legs, II legs 4-5 times longer than body	Pholcidae
—	Spiders without extremely long and thin legs	6

6 Tibia and metatarsi I & II with a row of long prolateral spines ..... Mimetidae
— Tibia and metatarsi I & II without a row of long prolateral spines 7
7 Tarsi IV with 6 to 10 serrated setae, forming a comb..... Theridiidae
— Tarsi without such a comb 8
8 Eye group in hexagonal arrangement ..... Oxyopidae
— Eye group not in hexagonal arrangement 9
9 Tarsi with numerous trichobothria 10
— Tarsi without trichobothria 13
10 Tarsal trichobothria in single dorsal row 11
— Tarsal trichobothria irregular, in two dorsal rows 12
11 The six spinnerets in a more or less transverse row ..... Hahniidae*
— The six spinnerets in three rows ..... Agelenidae*
12 Posterior row of eyes so strongly recurved that it may be considered to form two rows ..... Lycosidae
— Posterior row of eyes slightly recurved and not forming two distinct rows ..... Pisauridae
13 Chelicerae divergent from base, usually long and strong .. .. Tetragnathidae
— Chelicerae not divergent from base 14
14 Boss present on chelicerae ..... Araneidae
— Boss absent on chelicerae 15
15 Posterior spinnerets enormously long, usually longer than abdomen ..... Hersilidae
— Posterior spinnerets shorter and thicker, Tibia IV with 1 or 2 dorsal spines ..... Linyphiidae
16 Eyes in three rows; first row of two eyes, second row of four eyes, and third row of two eyes ..... Ctenidae
— Eyes in two rows 17
17 I & II legs enlarged and bearing scopulae 18
— I & II legs normal 19
18 Labium completely fused with sternum, two large anterior spinnerets and remnants of posterior four spinnerets present, carapace diamond shaped ..... Stenochilidae
— Labium not fused with sternum, only two spinnerets present, carapace oval ..... Palpimanidae*
19 Apex of metatarsus with a soft trilobate ..... Sparrassidae
— Apex of metatarsus otherwise 20
20 Chelicerae robust and provided with very long and slender fangs..... Prodidomidae
— Chelicerae otherwise 21
21 Eyes arranged in three rows, the front or anterior median eyes much larger ..... Salticidae
— Eyes arranged in two rows, the front or anterior median eyes not larger 22
22 Colulus present, legs I & II much longer than III & IV, spiders crab-shaped ..... Thomisidae
— Colulus absent 23
23 Tarsi I & II with scopulae ..... Philodromidae*
— Tarsi I & II without scopulae 24
24 Anterior spinnerets cylindrical, widely separated at base .. .. Gnaphosidae*
— Anterior spinnerets conical, separated by a distance much closer than their diameter 25
25 Clypeus narrower than a diameter of anterior median eyes (AME); if it is so, posterior median eyes (PME) separated by a distance of their diameter ..... Clubionidae
— Clypeus not narrower than the diameter of anterior median eye (AME), usually twice or wider; anterior lateral eyes (ALE) larger than AME ..... Corinnidae
26 Posterior median eyes largest and directed forward ..... Deinopidae
— Posterior median eyes of moderate size and not as above 27
27 Tarsi furnished with an ungual tufts and an inferior claw .. .. Psechridae
— Tarsi otherwise 28
28 Eyes homogeneous, light in colour, tarsi with a dorsal row of trichobothria ..... Amaurobiidae*
— Eyes homogeneous, dark in colour, or heterogeneous, light and dark in colour; tarsi without Trichobothria 29
29 Eyes homogeneous, dark; metatarsus IV compressed and concave above ..... Uloboridae
— Eyes heterogeneous, metatarsus IV of the usual shape (not compressed and concave above) ..... Dictynidae*
30 Six eyes, arranged in three separate groups 31
— Two, four or six eyes present and all arranged in one group 32
31 Carapace round and high behind, sternum round behind ..... Scytodidae*
— Carapace flat and depressed, sternum pointed behind ..... Loxoscelidae*
32 Eyes six; median eyes larger than laterals, located on anterior portion of carapace ..... Oonopidae*
— Eyes two, four or six, almost equal in size, located mostly on central portion of carapace ..... Tetrablemmidae*

*Not recorded from Parambikulam.

TAXONOMIC DIVERSITY

Family Diversity: Of the 59 families recorded in the Indian region, 22 families (38%) are found in Parambikulam Wildlife Sanctuary. Families Araneidae, Theridiidae, Tetragnathidae, Thomisidae, Salticidae and Theraphosidae exhibit maximum species diversity, which is closely associated with the diversity of habitats. Some rare families like Prodidomidae, Mimetidae, Deinopidae and Stenochilidae

are also recorded here. Mimetidae is a new record from southern India. Families consisting of hunting and wandering spiders (Lycosidae, Pisauridae, Oxyopidae, Sparrassidae, Clubionidae, Thomisidae, Philodromidae, Hersilidae and Ctenidae) represent 55% of the spiders found. Scytodidae, Loxoscelidae, Lyssomanidae, Gnaphosidae, Agelenidae which are collected from other regions of central Kerala, are not represented in our studies, perhaps because of the short study period.

Generic Diversity: Of the 252 genera recorded from the Indian region (Tikader 1987), 82 genera are found in Parambikulam. High generic diversity is found in Araneidae (11), Theridiidae (6), Thomisidae (10), Salticidae (7), Theraphosidae (6), and Tetragnathidae (7). The number of genera is higher than that of Andaman & Nicobar islands - 33 (Tikader 1970) Sikkim - 41 (Tikader 1977), and Calcutta (now Kolkata) - 47 (Tikader and Biswas 1981). Genera like *Arachnura* (Family: Araneidae); *Perenethis*, *Polyboeae* (Family: Pisauridae); *Pistius*, *Camaricus*, *Misumenops*, *Ozyptila*, *Tibellus*, *Xysticus*, *Strigoplus* (Family: Thomisidae); *Castianeira* (Family: Corinnidae); *Miagrammopes* (Family: Uloboridae); *Hyllus*, *Phintella*, *Telamonia* (Family: Salticidae); *Thelcticopis* (Family: Sparrassidae); *Chilobrachys*, *Thrigmopoeus* (Family: Theraphosidae); *Theridula*, *Argyrodes*, *Achaearanea*, *Theridion*, *Dipoena*, *Coleosoma* (Family: Theridiidae); *Linyphia* (Family: Linyphiidae); *Zimiris* (Family: Prodidomidae), *Deinopis* (Family: Deinopidae) are new records for Kerala.

Species Richness: 147 species were recorded from a limited area of 20 sq. km, a very high number compared to other regions like Andaman & Nicobar Islands - 65 (Tikader 1970), Sikkim - 55 (Tikader 1977) and Calcutta (now Kolkata) - 99 (Tikader and Biswas 1981). The three studies quoted above were conducted over a period of one to two years while the present study was limited to six days. Considering this, we believe that the diversity of spiders in Parambikulam is amongst the richest in India. A detailed survey will reveal much greater species diversity. Of the total species recorded, 112 are found in moist deciduous and 46 species in evergreen forests, and 29 in both habitats. Differentiation diversity index between the two habitats is 0.22, indicating high dissimilarity.

New Records: New species records for India are *Dipoena ruedai*, *Argyrodes flagellum* (Family: Theridiidae); *Hyllus diardi* (Family: Salticidae); *Perenethis mifasciata*, *Polyboea vulpina* (Family: Pisauridae). Species reported for the first time in Kerala are *Arachnura angura*, *Araneus nympha*, *Cyclosa bifida*, *C. confraga*, *C. hexatuberculata*, *C. quinqueguttata*, *C. spirifera*, *Cyrtophora bidenta*, *Eriovixia laglaizei*, *E. poonaensis*, *Gasteracantha dalyi*, *Neoscona vigilans* (Family: Araneidae); *Tylorida culta*, *Leucauge dorsotuberculata*, *L. pondae*, *Nephila kuhli*, *Tetragnatha andamanensis*, *T. vermiformis* (Family: Tetragnathidae); *Camaricus khandalaensis*, *Misumenops andamanensis*, *Misumena decorata*, *M. silveryi*, *Strigoplus netravathi*, *Xysticus himalayensis* (Family: Thomisidae); *Phintella vittata*, *Telamonia dimidiata* (Family: Salticidae); *Argyrodes gazedes*, *A. ambalika*, *A. gazingensis*, *A. xiphias*, *A. andamanensis*, *A. flagellum*, *Achaeranea durgae*, *A. diglipuriensis*, *Theridula angula*, *Theridion manjithar* (Family: Theridiidae); *Hippasa olivacea*, *H. lycosina* (Family: Lycosidae); *Oxyopes shweta* (Family: Oxyopidae); *Linyphia urbasae* (Family: Linyphiidae); *Deinopis* sp. (Family: Deinopidae); *Zimiris* sp. (Family: Prodidomidae); *Thrigomopoeus parambikulamensis*, *Plesiophrictus* spp., *Chilobrachys* sp., (Family: Theraphosidae).

Mygalomorph spiders: These large spiders live in burrows in the ground or in deep cavities or holes in large tree trunks. After the work of early arachnologists like Pocock (1900), Gravely (1915, 1935), Hirst (1909), the group has been largely neglected. Of the seven species previously reported from Kerala, five were reported from Parambikulam; *Haploclastus kayi*, *Plesiophrictus raja*, *P. bhori*, *Anandaliella travancorica* and *Poecilotheria striata* (Family: Theraphosidae). *P. striata* was the only arboreal mygalomorph found in Parambikulam. In addition, four new species were found during our study: *Chilobrachys* sp., *Plesiophrictus* sp. 1, *Plesiophrictus* sp. 2, *Anandaliella* sp., *Chilobrachys* sp. were discovered from the Evergreen forest of Karianshola and the burrows of *Plesiophrictus* sp. and *Haploclastus kayi* were found on embankments on the side of the road to Sálim Ali Centre at Kuriyarkutty. Besides these, *Poecilotheria rufilata*, *Anandaliella travancorica* (Family: Theraphosidae) were also recorded in Kerala, but not in Parambikulam.

Zoogeographic analysis: 36 species recorded in Parambikulam are widely distributed in many places in South Asia; 4 of these are found only in the Indo-Sri Lankan region. Most of these species belong to Araneidae (14) and Tetragnathidae (11). Because of bright coloration and large orb webs, spiders of these two families are easily observed, hence they are well represented in the literature. About 47 species found in Parambikulam are widely distributed in Kerala. Since the distributional status of Indian spiders is poorly known, species that are found in two widely separated regions are considered widely distributed. 15 species recorded from Parambikulam have so far been reported only from Kerala.

Endemism: Intensive agriculture and human settlements have destroyed the habitat of many spider species. Due to the disappearance of suitable habitats many species formerly widely distributed are now restricted to forest; *Gasteracantha remifera*, *G. dalyi*, *G. haselltii* (Family:

Araneidae) were earlier present in semi urban areas (Subrahmanyam 1954). The threat posed by habitat destruction is far greater to endemic species. Fifteen species discovered in Parambikulam are endemic to the Western Ghats of Kerala, while 44 are reported only from India. 51 species have been identified only up to generic level, of which many may be new species. The endemic species found in Parambikulam are *Gasteracantha geminata* (Family: Araneidae); *Ctenus indicus*, *C. cochinensis*, *Acantheis indicus* (Family: Ctendiae); *Psechrus alticeps* (Family: Psechridae); *Strigoplus uetravathi* (Family: Thomisidae); *Poecilotheria striata*, *Haploclastus kayi*, *Thrigmopoeus parambikulamensis*, *Plesiophrictus bhori*, *P. raja* (Family: Theraphosidae); *Tetragnatha cochinensis* (Family: Tetragnathidae); *Wadicosa (Lycosa) quadrifer* (Family: Lycosidae). Family Theraphosidae has three endemic genera: *Plesiophrictus* and *Poecilotheria* endemic to Indo-Sri Lankan region, and *Thrigmopoeus* found only in the Indian subcontinent. Of the 147 species found in Parambikulam, 45 are endemic to the Indo-Sri Lankan region.

Affinities: The spider fauna of Parambikulam bears affinities with Oriental and Palaearctic regions. Affinity with the island fauna of Sri Lanka is also pronounced. According to Holloway (1974), the Indian fauna was formed as a result of displacement by invaders from other regions of the Orient, after its separation from Gondwanaland and merger with Asia. Species having Sri Lankan affinities are *Argiope anasuja*, *Cyclosa bifida*, *C. insulana*, *Eriowixia laglaizei*, *Gasteracantha remifera* (Family: Araneidae); *Tylorida culta*, *T. ventralis*, *Opadometa fastigata*, *Nephila maculata*, *Tetragnatha ceylonica* (Family: Tetragnathidae); *Peceutia viridana* (Family: Oxyopidae); *Hersilia savigyni* (Family: Hersilidae); *Perenethis unifasciata* (Family: Pisauridae). Those with oriental affinities are *Argiope anasuja*, *Cyclosa bifida*, *C. confraga*, *Eriovixia laglaizei*, *E. poonaensis*, *Gasteracantha dalyi*, *G. haselltii*, *Neoscona rumphi* (Family: Araneidae); *Leucauge decorata*, *Nephila maculata*, *Tetragnatha ceylonica*, *T. andamanensis* (Family: Tetragnathidae); *Perenethis unifasciata*, *Polyboea vulpine* (Family: Pisauridae); *Dipoena ruedai* (Family: Theridiidae). A small fraction of species like *Araneus nympha*, *Eriovixia laglaizei*, *Gasteracantha hasseltti* (Family: Araneidae); *Nephila maculata* (Family: Tetragnathidae); show Palaearctic affinities.

DISCUSSION

The spider fauna of Parambikulam is rich and diversified. Of about 1,066 species reported from India (Tikader 1987), 147 species were recorded from Parambikulam. This high species diversity can be attributed to the high diversity of plants (1,300 species) and insects (1,000 species) Sudheendrakumar *et al.* (2000). A high floral diversity sustains a high faunal diversity of invertebrates. The complex interaction of climatic factors like high rainfall and humidity with topographical features creates many small environmental niches within evergreen forests, semi-evergreen forests, moist deciduous forests, dry deciduous forests, grasslands, bamboo areas and *vayals* (marshy areas). This makes Parambikulam an important centre of speciation in the Western Ghats.

Faunal similarity with other regions is also striking. *Artema atlanta* (Family: Pholcidae); *Argyrodes xiphias*, *A. andamanensis*, *Achaearanea diglipuriensis* (Family: Theridiidae); *Tetragnatha andamanensis*, *Nephila maculata* (Family: Tetragnathidae); *Hersilia savigyni* (Family: Hersilidae); *Pardosa sumatrana* (Family: Lycosidae); *Myrmarachne plateleoides* (Family: Salticidae) are also found in the spider fauna of Andaman and Nicobar islands (Tikader 1977). *Theridion manjithar*, *Argyrodes gazedes*, *Theridula angula* (Family: Theridiidae); *Cyrtophora bidenta*, *Cyclosa insulana*, *Gasteracantha hasseltii* (Family: Araneidae); *Leucauge decorata*, *L. tesellata*, *L. pondae*, *Nephila maculata* (Family: Tetragnathidae); *Oxyopes shweta* (Family: Oxyopidae) are species represented in the spider fauna of Sikkim (Tikader 1970). Species like *Artema atlanta*, *Crossopriza lyoni* (Family: Pholcidae); *Parawixia dehaanii*, *Cylosa insulana*, *Eriovixia poonaensis*, *Neoscona rumphi*, *Gasteracantha haselltii*, *Argiope pulchella* (Family: Araneidae); *Nephila maculata*, *Nephila kuhli*, *Tylorida ventralis*, *L.* decorata (Family: Tetragnathidae); *Pardosa sumatrana* (Family: Lycosidae); *Phintella vittata*, *Telamonia dimidiata* (Family: Salticidae) are also found in Kolkata (Tikader and Biswas 1981). Similarly, the collection of many South East Asian species from here indicates the close faunal relationship between the two regions. *Gasteracantha hasseltii*, *Eriovixia laglaizei*, *Parawixia dehaanii*, *Cyclosa bifida*, *C. insulana* (Family: Araneidae); *Nephila maculata*, *Leucauge decorata*, *Tylorida ventralis* (Family: Tetragnathidae); *Argyrodes flagellum* (Family: Theridiidae); *Crossoprioza lyoni* (Family: Pholcidae); *Polyboea vulpina*, *Perenethis unifasciata* (Family: Pisauridae); *Hyllus diardi*, *Phintella vittata*, *Telamonia dimidiata* (Family: Salticidae) are reported by Joseph Koh (1989) from Singapore. *Tetragnatha ceylonica*, *T. vermiformis*, *Nephila maculata*, *Leucauge decorata*, *Opadometa fastigata* (Family: Tetragnathidae); *Dipoena ruedai* (Family: Theridiidae); *Perenethis unifasciata* (Family: Pisauridae) *Hersilia savigyni* (Family: Hersilidae) are reported by Barrion and Litsinger (1995) from the Philippines.

Another feature of the spider fauna of Parambikulam is the occurrence of higher species and generic diversity in moist deciduous forests compared with evergreen forests.

Web-building families like Araneidae, Tetragnathidae, Psechridae, Theridiidae are more common in moist deciduous forests. We attribute this to the presence of rich undergrowth in moist deciduous forests, where spiders can construct webs, whereas absence of rich undergrowth in evergreen forests reduces the foliage area for web construction. The rich litter-covered surface in evergreen forests increases the abundance of ground dwelling spiders of families like Ctenidae, Pisauridae and Lycosidae. The paucity of spiders in the understorey of Evergreen forests may be due to their migration to the canopy. Since spiders are predators, they reside chiefly among foliage and flowers that attract flying insects. In evergreen forests, foliage and flowers of tall trees occur in the upper storey. No attempts were made to evaluate the spider fauna of canopies during the present study.

Parambikulam holds many endemic and rare species, like *Poecilotheria striata*, an arboreal mygalomorph spider that lives in the holes in the bark of tall trees. There are some unconfirmed reports that these spiders are now illegally trafficked out of the country in good numbers because of the growing demand by the pet trade to the West (Anon. 2000). Besides this, their specialized habitat is vulnerable to deforestation and logging. Ground dwelling mygalomorphs like *Haploclastus kayi*, *Plesiophrictus* sp., *Thigmopoeus* sp., *Chilobrachys* sp. may be destroyed by soil erosion or flooding. Conservation of natural habitats is essential for the survival of many species as well as adoption of appropriate conservation strategies for effectively safeguarding genetic diversity.

Although the widely distributed spiders are more numerous in Parambikulam, the characteristic faunal element is the high number (45) of endemic species, whose faunistic composition reflects the local character of the fauna. Many of the species are not reported from any region in India other than Kerala. This phenomenon can be explained by the relative isolation of Western Ghats provided by mountains in the East and the Arabian Sea in the West. The Western Ghats thus appear to represent a major centre of speciation in Asia. Holloway *et al.* (1992) observed that conversion of forest to plantation and other man-induced disturbances lead to reduction in the diversity of invertebrates, both in species richness and in the taxonomic and biogoeographic quality. Teak plantations should therefore be replaced, in the sanctuary, with natural forest, and top priority must be given to the conservation of its rich diversity.

Table 1: List of spiders collected from Parambikulam Wildlife Sanctuary during the study

Scientific name	Habitat	Status	Distribution
Family: Theraphosidae			
1. *Anandaliella* sp.	M	R	
2. *Anandaliella travancorica*, Hirst 1909	M	R	IND: KL
3. *Chilobrachys* sp.	M	R	
4. *Haploclastus kayi* Gravely, 1915	M	R	IND: PBKL
5. *Plesiophrictus bhori* Gravely, 1915	M	R	IND: PBKL
6. *Plesiophrictus raja* Gravely, 1915	M	R	IND: PBKL
7. *Plesiophrictus* sp. 1	M	R	
8. *Plesiophrictus* sp. 2	M	R	
9. *Poecilotheria striata* Pocock, 1895	M	R	IND: PBKL
10. *Thrigmopoeus parambikulamensis*, Sanjay & Daniel, 2002	M	R	IND: PBKL
Family: Pholcidae			
11. *Artema atlanta* Walckenaer, 1837	M	R	PAN
12. *Crossopriza lyoni* (Blackwall, 1867)	M	R	COS
Family: Mimetidae			
13. *Mimetus* sp.	M	R	
Family: Hersilidae			
14. *Hersilia savigyni* Lucas, 1836	M	C	IND; SLK; PHL
15. *Tama gravelyi* Sinha, 1950	-	-	IND: PBKL
Family: Deinopidae			
16. *Deinopis* sp.	E	R	
Family: Uloboridae			
17. *Miagrammopes* sp.	E	R	
18. *Uloborus danolius* Tikader, 1969	M	C	IND: WB, AN, MH
19. *Uloborus krishnae* Tikader, 1970	M	C	IND: GJ, SI, AN
20. *Zosis geniculatus* (Oliver, 1789)	M	R	PAN
Family: Theridiidae			
21. *Achaearanea diglipuriensis* Tikader, 1977	M	R	IND: AN
22. *Achaearanea durgae* Tikader, 1970	M	C	IND: SI
23. *Achaearanea mundula* (L. Koch, 1872)	M	R	IND: NEC
24. *Achaearanea* sp.1	M	R	
25. *Argyrodes xiphias* Thorell, 1873 (*Argyrodes carnicobarensis* Tikader, 1977)	M	C	IND: AN; MYN; JAP; KRK
26. *Argyrodes ambalika* Tikader, 1970	M, E	R	IND: SI
27. *Argyrodes andamanensis* Tikader, 1970	M	R	IND: AN

Table 1: List of spiders collected from Parambikulam Wildlife Sanctuary during the study (*contd.*)

Scientific name	Habitat	Status	Distribution
28. *Argyrodes flagellum* Doleschall, 1857	E	R	SGP; MYN
29. *Argyrodes gazedes* Tikader, 1970	M	C	IND: SI
30. *Argyrodes gazingensis* Tikader, 1970	M	R	IND: SI
31. *Argyrodes* sp.	M	R	
32. *Coleosoma* sp.	M	R	
33. *Dipoena ruedai* Barrion & Litsinger, 1995	M	R	PHL
34. *Theridion manjithar* Tikader, 1970	M	R	IND: SI
35. *Theridula angula* Tikader, 1970	M	C	IND: SI
36. *Theridion* sp.	M	R	
Family: Linyphiidae			
37. *Atypena* sp.	M	R	
38. *Lephthyphantes* sp.	M	R	
39. *Linyphia urbasae* Tikader, 1970	M, E	R	IND: SI
40. *Linyphia* sp.	E	R	
41. *Linyphiidae* sp. 1	E	R	
42. *Linyphiidae* sp. 2	E	R	
Family: Tetragnathidae			
43. *Herennia ornatissima* (Doleschall, 1859)	M	R	IND: PBKL, TN; CHN; MAL; NEG
44. *Leucauge decorata* (Blackwall, 1864)	M, E	C	IND: KL, UP, SI, WB; PAL
45. *Leucauge dorsotuberculata* Tikader, 1980	M	C	IND: MH
46. *Leucauge pondae* Tikader, 1970	M, E	C	IND: SI
47. *Leucauge tesselata* (Thorell, 1887)	M	C	IND; MLC; TAW
48. *Nephila kuhli* Doleschall, 1859	M, E	C	IND: WB; SLW
49. *Nephila maculata* (Fabricius, 1793)	M, E	C	IND; BHT; MYN; CHN; JAP
50. *Opadometa fastigata* (Simon, 1877)	M, E	C	IND: PBKL, KL, OR, UP; SLK; PHL; SLW
51. *Orsinome marmorea* Pocock, 1901	-	-	IND: KL, TN, MH, KR
52. *Tetragnatha vermiformis* Emerton, 1884 (*Tetragnatha mackenziei* Gravely, 1921)	M	R	IND: KL, OR, KR, BI, WB; EAS
53. *Tetragnatha andamanensis* Tikader, 1977	M	R	IND: KL, AN
54. *Tetragnatha ceylonica* Cambridge, 1869 (*Tetragnatha gracilis* Pocock, 1900)	M	C	IND: KL, TN, KR; SLK; MYN; PHL
55. *Tetragnatha cochinensis* Gravely, 1921	M	R	IND: KL
56. *Tetragnatha maxillosa* Thorell, 1895 (*Tetragnatha listeri* Gravely, 1921)	-	-	IND: KL; SAF; BGL; PHL; NEH
57. *Tetragnatha sutherlandi* Gravely, 1921	M	R	IND: KL, WB, BI, MG
58. *Tylorida culta* (O.P. Cambridge, 1869) (*Leucauge culta* O.P. Cambridge, 1869)	M	R	IND: WB, KR, TN; SLK
59. *Tylorida ventralis* (Thorell, 1877) (*Leucauge ventralis* (Thorell, 1877)	M	C	IND: KL, WB; SLK; NEG; TAW
Family: Araneidae			
60. *Arachnura angura* Tikader, 1990	M, E	R	IND: SI
61. *Araneus nympha* Simon, 1899	M, E		IND: HIM; SLK; PAK; MAL
62. *Argiope anasuja* Thorell, 1887	M, E	C	IND: TN, MH, OR, WB; SLK; PAK; MAL
63. *Argiope pulchella* Thorell, 1881	E	C	IND: AN, LD, WB, MP, OR, AS, MH, TN; MYN; MAL
64. *Argiope* sp.	M	R	
65. *Chorizopes* sp.	M	R	
66. *Cyclosa bifida* (Doleschall, 1859)	E	R	IND: MG; MYN; SLK; NEG; MAL
67. *Cyclosa confraga* (Thorell, 1892)	M, E	R	IND: SI, AS, MH; MAL; BGL; MYN
68. *Cyclosa hexatuberculata* Tikader, 1982	M	R	IND: MH
69. *Cyclosa insulana* (Costa, 1834) (*C. moesta* Blackwall, 1865)	M	R	IND; SLK; MYN; PHL; AUS
70. *Cyclosa quinqueguttata* (Thorell, 1883) (*C. fissicauda* Simon, 1889)	M, E	R	IND: SI; BHT; MYN; CHN; TAW
71. *Cyclosa spirifera* Simon, 1889	M, E	R	IND
72. *Cyrtarachne* sp.	M, E	C	
73. *Cyrtophora bidenta* Tikader, 1970	M	R	IND: SI
74. *Eriovixia laglaizei* Simon, 1877 (*Neoscona laglaizei* (Simon, 1877)	M, E	C	IND: TN; MYN; CHN; SLK; AUS; MAL; NEG; PHL
75. *Eriovixia poonaensis* (Tikader & Bal, 1981) (*Neoscona poonaensis*, 1981)	M	R	IND: MH, WB
76. *Gasteracantha dalyi* Pocock, 1900	M	R	IND: TN; PAK
77. *Gasteracantha geminata* (Fabricius , 1798)	M, E	C	IND: KL, TN; SLK

Table 1: List of spiders collected from Parambikulam Wildlife Sanctuary during the study (*contd.*)

Scientific name	Habitat	Status	Distribution
78. *Gasteracantha hasselti* C.L. Koch, 1837	M, E	C	IND: KL, TN, WB, AS, SI; MYN; CHN; MOL
79. *Gasteracantha kuhli* C.L. Koch, 1837	M	R	IND; PHL; JAP
80. *Gasteracantha remifera* Butler, 1873	M	R	IND; SLK
81. *Gea* sp. 1	M	R	
82. *Neoscona mukerjei* Tikader, 1980	M	R	IND: WB, MH
83. *Neoscona nautica* (L. Koch, 1875)	M	R	IND: MH, GJ, WB; COS
84. *Neoscona pavida* (Simon, 1906)	M	R	IND: WB; PAK; CHN
85. *Neoscona vigilans* (Blackwall,1865) *Neoscona rumphi* (Thorell, 1887)	M	R	IND; MYN; PAK; SLK; AUS; MAL
86. *Parwixia dehaani* (Doleschall, 1859)	E	R	IND: KL; AUS; MAL
Family: Lycosidae			
87. *Evippa* sp.	M	R	
88. *Hippasa agelenoides* (Simon, 1884)	M, E	C	IND; TAW
89. *Hippasa greenalliae* (Blackwall, 1867) (*H. pantherina* Pocock, 1899)	M, E	C	IND; SLK; CHN
90. *Hippasa leucostigma* Simon, 1885	-	-	IND
91. *Hippasa lycosina* Pocock, 1900 (*H. nilgiriensis* Gravely, 1924) (*H. mahabaleshwarensis* Tikader & Malhotra, 1980)	-	-	IND; CHN
92. *Hippasa olivacea* (Thorell, 1887)	M, E	R	IND; MYN
93. *Lycosa madani* Pocock, 1901	-	-	IND: PBKL
94. *Pardosa sumatrana* (Thorell, 1890)	M, E	C	IND: TN, KR, WB, UT, BI, MH; NEP
95. *Pardosa atropalpis* (Gravely, 1924)	M	C	IND: TN, KL, AN, KR, OR, BI, WB
96. *Wadicosa quadrifer* (Gravely, 1924) (*Lycosa quadrifer* Gravely, 1924)	-	-	IND: PBKL
97. *Lycosa* sp. 1	M	R	
98. *Lycosa* sp. 2	M	R	
Family: Pisauridae			
99. *Perenethis unifasciata* (Doleschal, 1859)	M	R	SLK; MYN; SGP; NEG
100. *Pisaura* sp.	M	R	
101. *Polyboea vulpina* Thorell, 1895	E	C	MYN; THL; SGP; MAL

Table 1: List of spiders collected from Parambikulam Wildlife Sanctuary during the study (*contd.*)

Scientific name	Habitat	Status	Distribution
Family: Oxyopidae			
102. *Oxyopes ashae* Gajbe, 1999	E	R	IND
103. *Oxyopes birmanicus* Thorell, 1887	M	C	IND; CHN, SUM
104. *Oxyopes shweta* Tikader, 1970	M	C	IND: SI; TAW
105. *Oxyopes* sp. 1	M	C	
106. *Peucetia viridana* (Stoliczka, 1877)	M	R	IND: TN, WB, KL; SLK
Family: Stenochilidae			
107. *Stenochilus hobsoni* O.P. Cambridge, 1870	M	R	IND: TN, AP, MH, RJ
Family: Psechridae			
108. *Psechrus alticeps* (Pocock, 1899)	M, E	C	IND: KL
Family: Ctenidae			
109. *Ctenus indicus* Gravely, 1931	E	C	IND: KL
110. *Ctenus* sp. 1	E	R	IND: UT
111. *Ctenus* sp. 2	E	R	
112. *Ctenus cochinensis* Gravely, 1931	-	-	IND: PBKL
113. *Acanthies indicus* Gravely, 1931	-	-	IND: PBKL
Family: Clubiuonidae			
114. *Cheiracanthium* sp.	E	R	
115. *Oedignatha microsculata* Reimoser, 1934	-	-	IND: PBKL
116. *Oedignatha carli* Reimoser, 1934	-	-	IND: PBKL
Family: Corinnidae			
117. *Castineira* sp.	E	R	
Family: Prodidomidae			
118. *Zimiris* sp.	M	R	
Family: Sparrassidae			
119. *Heteropoda leprosa* Simon, 1884	M, E	C	IND; MAL; MYN
120. *Heteropoda* sp.	M	C	
121. *Palystes flavidus* Simon, 1897	M	R	IND: TN, OR, WB, UP
122. *Thelcticopis* sp.	M	R	
Family: Thomisidae			
123. *Camaricus khandalaensis* Tikader, 1980	M	R	IND: MH
124. *Misumena decorata* Tikader, 1963	M	R	IND: KR
125. *Misumena silveryi* Tikader, 1965	M	R	IND: MH
126. *Misumena* sp.	M	R	

Table 1: List of spiders collected from Parambikulam Wildlife Sanctuary during the study (*contd.*)

Scientific name	Habitat	Status	Distribution
127. *Misumenops andamanensis* Tikader, 1980	M	R	IND: AN
128. *Misumenops* sp.	M	R	
129. *Ozyptila* sp.	M	R	
130. *Pistius* sp.	M	R	
131. *Strigoplus netravathi* Tikader, 1963	M	R	IND: KR
132. Thomisidae sp. 1	M	R	
133. Thomisidae sp. 2	M	R	
134. *Tibellus* sp. 1	M	R	
135. *Tibellus* sp. 2	M	R	
136. *Xysticus himalayaensis* Tikader & Biswas, 1974	M	R	IND: WB
137. *Xysticus* sp.	M	R	
Family: Salticidae			
138. *Hyllus diardi* (Walckanaer, 1837)	M	C	MAL; IDS; THL; MYN; VET; SGP
139. *Hyllus* sp.	M	R	
140. *Myrmarachne plataleoides* Cambridge, 1869	M	C	IND: WB, BI, KL; SLK; THL; SGP
141. *Myrmarachne* sp. 1	M	C	
142. *Myrmarachne* sp. 2	M	R	
143. *Phintella vittata* C.L. Koch, 1845 (*Salticus ranjitus*, Tikader, 1967)	M	R	IND: SI, GJ; IDS; VET; CHN; MAL
144. Salticidae sp. 1	M	R	
145. Salticidae sp. 2	M	R	
146. Salticidae sp. 3	M	R	
147. *Telamonia dimidiata* (Simon, 1899) (*Phidippus pateli* Tikader, 1974)	M, E	C	IND; SGP

Abbreviations used in the table: AUS = Australia, BGL = Bangladesh, BHT = Bhutan, CHN = China, COS = Cosmopolitan, EAS = Eastern Asia, HIM = Himalaya, IDA = Indonesia, IND = India, JAP = Japan, KRK = Krakatau, MAL = Malaysia, MLC = Molucos, MLD = Maldives, MYN = Myanmar, NEB = New Britain, NEC = New Caledonia, NEG = New Guinea, NEH = New Hebrides, NEP = Nepal, PAK = Pakistan, PAL = Paleotropical, PAN = Pan tropical, PHL = Philippines, QSL = Queensland, SAF = South Africa, SGP = Singapore, SLK = Sri Lanka, SLW = Sulawesi, SUM = Sumatra, TAW = Taiwan, THL = Thailand, VET = Vietnam; AN = Andaman & Nicobar Islands, AS = Assam, BI = Bihar, GJ = Gujarat, KL = Kerala, KR = Karnataka, LD = Lakshadweep, MG = Meghalaya, MH = Maharashtra, MP = Madhya Pradesh, OR = Orissa, RJ = Rajasthan, SI = Sikkim, TN = Tamil Nadu, UP = Uttar Pradesh, UT = Uttarakhand, WB = West Bengal; R = Rare, C = Common; M = Moist Deciduous forest, E = Evergreen forest; PBKL = Parambikulam.

Small dash indicates that the species was not collected during the present study, but has been previously reported from Parambikulam.

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